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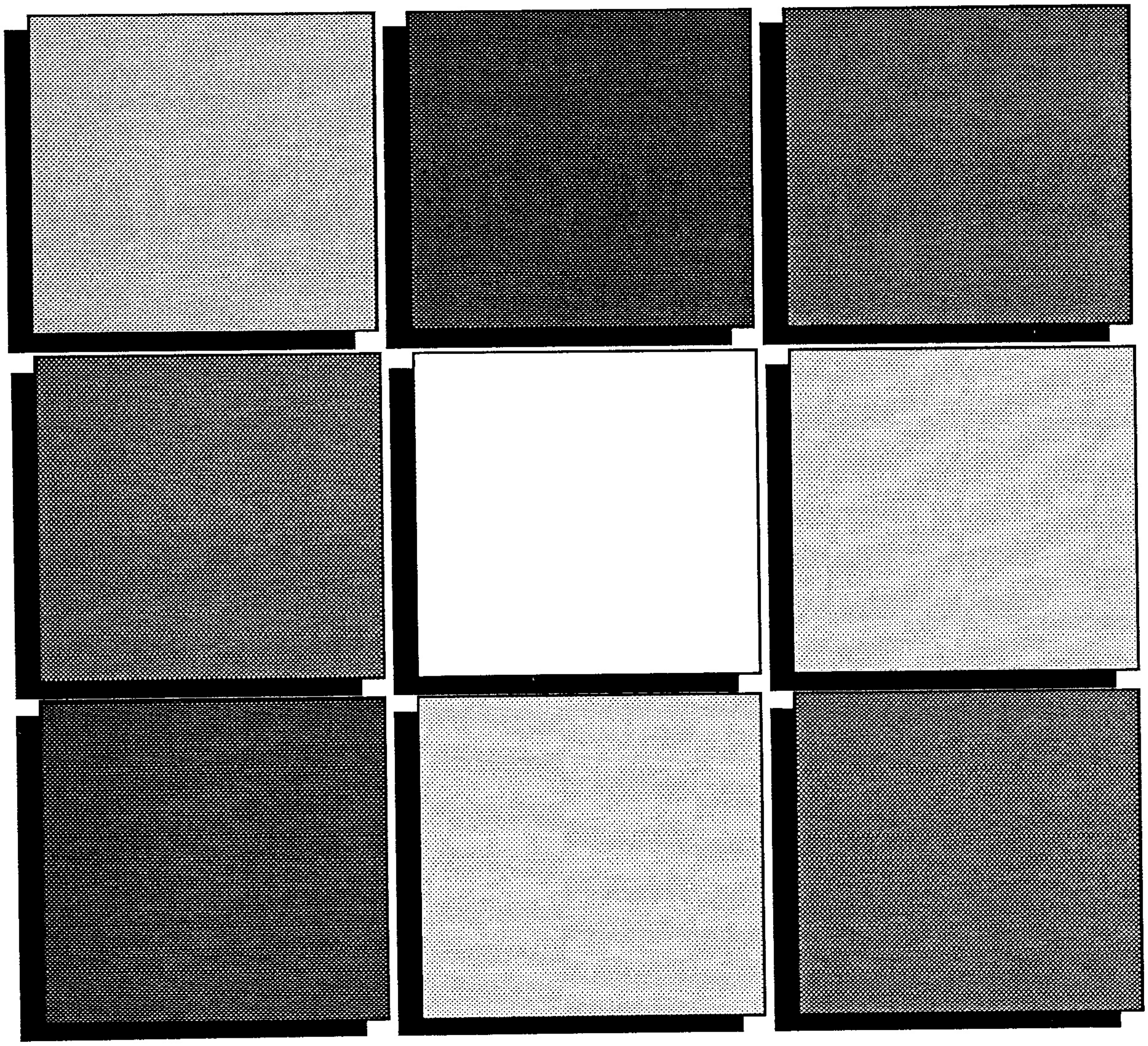

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Dr. Know:
Introductory Experiments in Artificial Intelligence

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What is Artificial Intelligence?

There are many ways to define Artificial Intelligence (AI). A simple definition is that AI is a discipline that is a part of computer science which studies the processes for creating human-like intelligence in a machine.

Many new and exciting developments in computer hardware make it possible to incorporate artificial intelligence (AI) techniques in the design of software. The technology used in the development of AI is emerging. The general goal of much AI research is to program computers to perform tasks that require intelligence. In the recent past, for a variety of reasons mostly related to the availability of hardware, the use of AI programs was restricted to labs and university computer centers. Today, however, the personal computers found in many schools and homes are capable of running AI programs.

To many people, pioneers in AI research seem to be wizards creating human-like robots. The concept of artificial intelligence may bring to mind a vision of Hollywood-inspired humanoids whose programming usually turns against their designers. Artificial intelligence as a discipline does include robotics, of course, but the real robots that are used in modern industries are very different from the type of robots presented in the movies. As we know, these fictional representations of artificially intelligent robots are designed to entertain, while real state-of-the-art robots tend to look more like motorized bugs and are designed to perform a specific task. Thus, even though artificial intelligence as a discipline does include robotics, the real robots that are used in modern industries are very different from the type of robots presented in the movies.

Actually robotics is only one aspect of the research and development that is involved in creating practical applications for artificial intelligence. In addition to robotics, artificial intelligence research includes the study of natural language processing, expert systems, knowledge engineering, deduction and theorem proving systems, simulated learning, and other areas of software and hardware design such as simulating the function of sense organs.

Experts predict that as the promise of Artificial Intelligence will be realized in the 1990's, society will benefit greatly, for the true potential of computers to benefit mankind will become apparent. Artificial Intelligence is a relatively new area of computer science that is unfamiliar to many people. Educators, as a group, may be unfamiliar with Artificial Intelligence, however its impact on education will be significant. Using Dr. Know you will begin to understand the answer to the question, "What is Artificial Intelligence?". The program will provide you with an opportunity to experiment with different areas of AI research. Activities are suggested in this manual that will serve to guide your explorations.

In the computer industry, AI is still primarily in need of extensive research and development. The results of certain areas of research in AI are being implemented in commercial business software. For example, artificially intelligent database management programs have been developed. In education, the application of artificially intelligent programming is yet to be realized. Dr. Know is a starting point for your own personal exploration into the vast potential of AI for education.

Looking Back

The concept of artificial intelligence and the technology for how to develop it reflects the philosophical outlook of the period. The dream of intelligent machines is not new. It is surprising to note that references to Artificial Intelligence can be found in writings from the Middle Ages. Groups of scientists, philosophers and religious leaders discussed the possibilities of developing artificial humans through combining various mixtures and potions. As society moved into the industrial age, mechanical humans were designed by skilled clock makers.

The invention of computers brought about the development of scientific discipline dedicated to the study of Artificial Intelligence. Simulating human thought processes requires enormous amounts of computing power. Early attempts to use computers to emulate human activities such as playing a game or understanding language failed. In the 1950's AI research focused on neural networks. At the time breakthroughs in understanding the structure of the human brain were occurring and the AI scientists attempted to replicate the complex networks of neurons in the brain using programming models. However, it is estimated that the brain has over 10 billion neurons with trillions of possible networks. Today's computer technology is still working with thousands, and in some cases, millions of memory positions, so it is little wonder that the AI research using limited computers of the 50's was unsuccessful.

It was realized that in order to continue the study of artificial intelligence, the focus needed to be narrowed and a great deal needed to be learned about how humans think. Some AI researchers in the 60's became fascinated with the development of programs to enable computers to play chess. But the number of possibilities in a chess game proved to be a great challenge and the early programs were very limited. While the effort to develop computer chess playing ability may seem to be interesting but of little value, it did lead the way into a useful area of AI research, the search for general rules that can be used to describe human behavior in certain situations.

As faster, more powerful computers were developed in the 70's, it became possible to create truly useful AI applications. Robotics became an important field and computer programs were developed that directed the operation of various machines in factories.

Large numbers of people use computers today. The relationship between the human and the machine, the interface, is an extremely important aspect of hardware and software design that has direct bearing on productivity.

Modern AI research encompasses many diverse areas. Speech synthesis and voice recognition are two areas in the design of the human interface that have the potential to make computers even more useful. Giving computers the ability to understand human language is a very difficult challenge because of the complexities of language, but it is one area where progress has been made and will be increasingly more important as the memory capacities of personal computers is expanded. Expert systems (designing a program to simulate the actions of an expert) have already been designed and can be used to perform useful functions.

Introduction to Dr. Know

Dr. Know provides an introduction to AI and to the use of AI in education, and allows students to experiment with the principals of artificial intelligence. Learning to perform calculations with a computer is always going to be important for students, but students also need to learn to solve logic problems using programming. One of the most important aspects of artificial intelligence research students can work with using Dr. Know is the area of knowledge engineering.

Knowledge engineering deals with the organization of a database of information about a particular subject in a specific way for a logical reason. Consider as an example a program where the user could enter a series of phrases about animals, such as:

"A cat is a feline"
"A feline is a mammal"
"A mammal is a furry animal"

An example of Artificial Intelligence would be if the user could then ask the computer a question such as "Is a cat a furry animal?" and the computer would respond with "Yes", thus drawing a conclusion from the information that it has been given.

Dr. Know is capable of solving this type of problem and also of explaining the reason used to arrive at the conclusion. However, in order to solve certain problems, the knowledge must be represented in such a way that an accurate internal model of the world is created in the computer's memory. The model must contain relevant information about the relationship between various elements of the reality being modeled.

In the example above, because the information is structured correctly, the computer would be able to conclude that "A dog is a furry animal", if it were told that a dog is a canine and a canine is a mammal. For the program to reason correctly, the information used in the model must also be accessible. For example, if the computer's information base contained information about dogs which always referred to dogs only by the word "dog", the user would not be able to access the information using the word "German Shepherd". (The user could tell the computer that a German Shepherd is a dog, and proceed from there.)

Another classic area of artificial intelligence research that has been implemented in Dr. Know is a conversational interface or natural language processing system. Here the potential for education is significant since in many educational computer programs, the user is limited to entering only single letter answers offered as choices by the computer, such as "Is the answer A, B, or C?". Dr. Know makes it possible to explore natural language processing in the classroom since it has been designed to make it possible to enter phrases and sentences in a somewhat open-ended format. However, because of the complexities of human language, natural language processing systems require enormous amounts of memory. Thus, in order to implement a natural language processing system on a microcomputer, it was necessary to limit vocabulary and types of sentence structures used in the system.

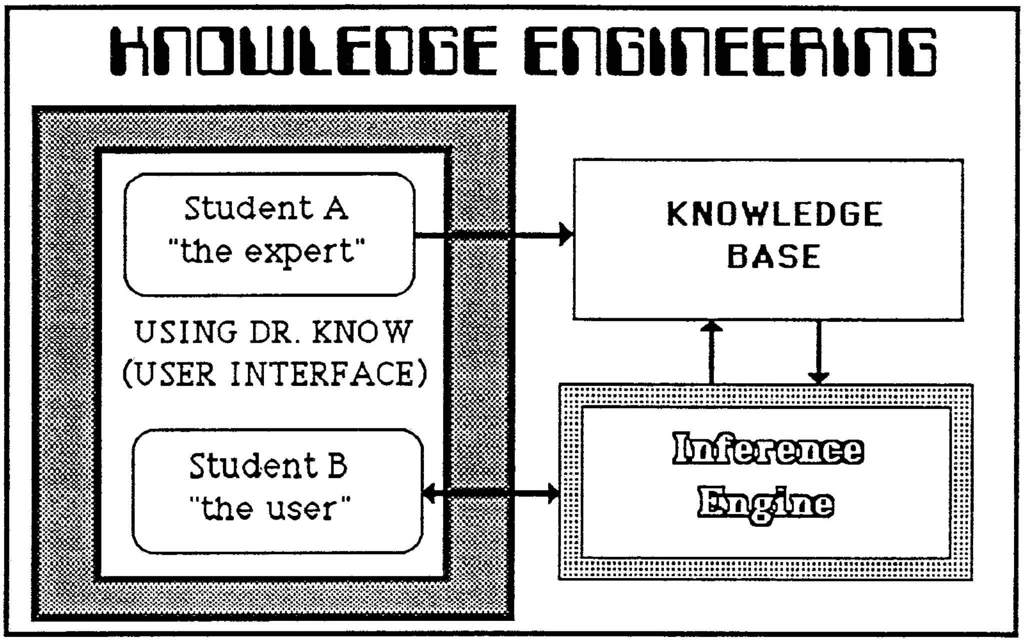
In Dr. Know, microcomputer-based natural language-processing algorithms have been implemented in the various sections of the system to process certain English sentences. For example, in the program titled 'Hierarchies' it is possible to enter information about a subject using natural sentences.

If the user were setting up a knowledge base on mammals, the user would need to enter "A mammal is a furry animal" rather than "A mammal has fur". Because of the limitations of available memory in a microcomputer, Dr. Know is set up to receive information using the verb "is" rather than "has". More information about the syntax that can be used with Dr. Know is in the Activities Section of this manual. While there are some limitations to the language that can be used with Dr. Know, the natural language processing system implemented in Dr. Know allows the user to experience benefits and limitations of natural language processing without having to be conversant in a technical computer programming language.

An additional area of artificial intelligence research is the use of software systems classified as "expert systems". This is one area of AI that has been implemented in many areas of business and industry. In an expert system, the program is based on the knowledge and experience of an expert. In the field of medicine, for example, expert systems have been designed that are databases of information pertaining to the diagnosis of disease. As a patient answers a series of questions asked by the computer, the program logically rules out certain possible diagnoses and asks further questions about other possible diagnoses, eventually leading to a partial or full diagnosis.

The potential for the use of expert systems in education has yet to be fully explored. In Dr. Know, students are able to design and experiment with expert systems on any subject. One example of a simple expert system is presented in the activities on classifying triangles. Any triangle can be classified on the basis of its angles as either obtuse, right or acute. In setting up the expert system students must determine what the critical difference is for each type of triangle and then write three questions that will allow the computer to recognize a particular triangle. Since the student is the 'expert' he or she must train the computer in how to classify a triangle.

Once the expert system has been set up and the 'expert' has verified that it works correctly, other students can use the program to classify triangles. The chart below shows how the process of knowledge engineering works. Dr. Know is the inference engine.



Hardware Requirements

Dr. Know is designed to work on any Apple // computer. The hardware requirements are listed below:

Apple //e, Apple //c or Apple //+ Computer System
48K RAM (minimum)
Single or Dual Disk
Video Monitor (Color recommended for some parts of the program)
DOS 3.3/Applesoft BASIC
Storage Disk (DOS 3.3 format)

Getting Started

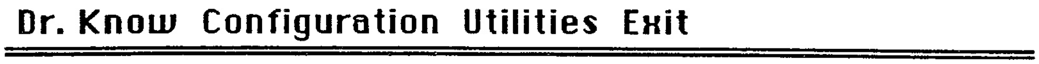
Before you begin using Dr. Know, make a backup of the program disk by copying the disk using the COPYA program on the Apple System Master. Use the copy and store the original in a safe place. The purchaser of this program is entitled to keep one backup of this program for archival purposes. Using the backup in a second computer or making more than one copy is considered a copyright infringement.

Dr. Know is started by placing the program disk in Drive 1 and a storage disk in Drive 2 (if available). With the disk in place either power ON the system or reboot by pressing CTRL-Open Apple-Reset. Use PR#6 to warm-start on Apple //+ systems. Please consult your Apple User's Guide for more complete system operating instructions.

Menu System

Dr. Know is designed to encourage exploration. The menu system which is part of the AI interface permits the user to move easily from one part of the program to another. Each of the main options in Dr. Know is a branch or pathway that can be used to explore a different aspect of artificial intelligence. Dr. Know can be used in a variety of curriculum areas. The examples in this teacher's guide are designed to suggest ways in which the use of Dr. Know can be integrated with the traditional curriculum.

Consistently throughout the use of Dr. Know, a menu bar is used at the top of the screen. The options in each menu can be selected by pressing the right or left arrow keys or by pressing the first letter of the desired option. Whenever appropriate, the escape key can be used to exit the current menu and return to a higher level menu. When the program has been properly started, the menu shown below will appear on the screen.

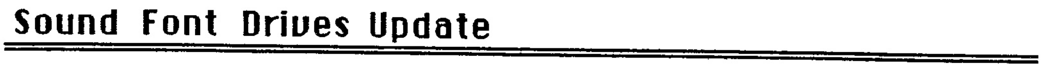


Dr. Know

The "Dr. Know" option from the main menu is used to access all of the AI programs. These programs are described individually and in more detail in the section following the explanation of the main menu.

Configuration

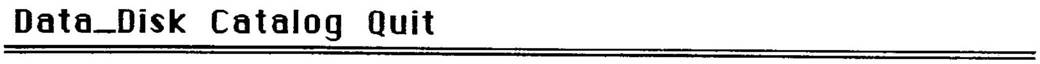
Options can be selected from the menus by pressing the first letter of the option or by using the arrow keys to move the highlight to the option and then pressing RETURN to select the option. Select the configuration option by pressing the letter 'C'. The configuration menu shown below will appear.



Sound -	Sound is used at various places in the program. The default for sound is for it to be active. The sound can be made active or inactive from the configuration menu. To make the sound inactive, press 'S' for Sound and then press 'I' for Inactive. Return to the configuration menu by pressing 'C' for cancel.
Font -	Two different styles of characters can be used in Dr. Know. To set either plain or bold characters, select 'F' for Font from the configuration menu, and then choose 'P' for plain or 'B' for bold (the default).
Drives -	The number of drives available on the system can be set from the Drives option of the configuration menu. From the main menu, press the right arrow key to move the indicator so that it will highlight the word 'Configuration'. Press RETURN, then move the indicator to the word 'Drives' and press return again. Now select 1 or 2 for the number of drives on your system.
Update -	Select update after the desired configuration has been selected and the options are stored on the program disk.

Utilities

The utilities option from the main menu allows the user to create a storage disk and to view the catalog of a disk. Select 'U' from the main menu and the utilities menu shown below will appear. Select 'D' from the utilities menu to make a data disk which can be used to store knowledge bases that are developed using other parts of the program. Select 'C' to view the catalog of a disk and select 'Q' to return to the main menu. When using the 'D' option, be sure that the original program disk has been backed up.

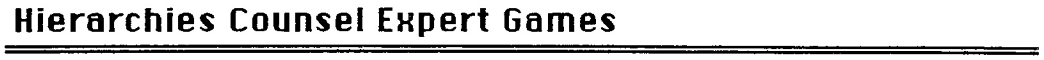


Data Disk -	The Data Disk option is used to create a storage disk to be used in storing files that are produced in other parts of the program. The Data Disk option completely erases the target disk, so be careful when using this option. After selecting 'D' from the utility menu, follow the instructions on the screen to prepare a data disk.
Catalog -	The Catalog option from the main menu is used to view

the files on a diskette. After selecting the Catalog option, choose either 1 or 2 to select the drive.

Introducing the AI Programs

Selecting Dr. Know from the main menu leads to four program options which are selected from the menu which is shown below.



Each of the main components of Dr. Know explores a different aspect of artificial intelligence and is discussed in a separate section.

Hierarchies

The Hierarchies program allows the user to enter simple English sentences in order to create a knowledge base with a hierarchical structure. A hierarchically structured knowledge base can be used to represent relationships among uniquely identifiable classes. The sentences that are entered when using this program should be carefully selected in order to construct an accurate knowledge base for a particular subject. Once created, the knowledge base can be stored, retrieved and modified.

The knowledge base is created using a series of sentences. Here is an example of a dialogue that could take place using the Hierarchies program.

A bean is a dicot.
A pea is a monocot.
A dicot is an angiosperm.
A monocot is an angiosperm.
An angiosperm is a pteropsid.
A pteropsid is a tracheophyte.
Is a bean a tracheophyte?
Yes.
Explain.
This is my reasoning:
A bean is a dicot.
A dicot is an angiosperm.
An angiosperm is a pteropsid.
A pteropsid is a tracheophyte.
Therefore a bean is a tracheophyte.

In the activities section of this manual, a step-by-step guide explains how to use this program and provides examples of some practical applications.

Counselor

The Counselor program illustrates how the computer can be used to simulate an intelligent conversation and to provide students with an opportunity to create their own scripts for simulating intelligent conversation. The program is based on the work of Joseph Weizenbaum, a professor of computer science at the Massachusetts Institute of Technology. The original program on which the program is based was called Eliza and was completed in 1966. The program created quite a controversy when it was first released. It was designed to parody the interaction of a Rogerian therapist and his client. In Rogerian psychotherapy, the therapist refuses to take the lead in conversation, and continually reflects what the client is saying by restating the comments. Weizenbaum was surprised to find that people actually found the use of his program beneficial.

The Counselor program uses triggers to direct the conversation. A trigger is a key word or phrase that causes a response to be elicited from a particular set of responses. For example, if you type "I am fine.", Dr. Know may respond with "Please tell me more about how you feel." In this example, "I am fine" is a trigger which causes the computer to respond with the sentence "Please tell me more about how you feel." When the user enters a sentence and the computer is unable to find a trigger, Dr. Know will select and give a random response that is designed to prompt the user to continue the conversation.

The Dr. Know program disk contains two sample conversation files that contain triggers and associated responses. One is called General, and the other is called School. In addition to these two sample files, up to seven other files can be created by the user. (Limited by disk space.) The procedure for creating new conversation files is explained in the activity section.

Expert

The Expert program is designed to allow the user to experiment with a program that actually learns from experience. Once Dr. Know's expert system has been trained it is able to select the correct outcome based on the answers to a series of questions. At first, the Expert program may come to incorrect solutions. But the program learns from its mistakes and as the user guides the program to the correct conclusion, it will increasingly arrive at the correct outcome. Eventually the system will always arrive at the correct conclusion.

In using the program, students will realize that careful planning is required to set up an expert system. Using Dr. Know, the user can develop simple expert systems for any subject area. A sample system is provided on the program disk that will classify triangles on the basis of answers to questions about the size of their angles. Up to eight other systems can be set up by the user and stored on a disk.

Games

The Games option from the main menu leads to another menu. The games on Dr. Know are logic games and require the use of deductive reasoning. The options available are:

Yes/No Bagels Hi-Lo Grids

Each game is described briefly below. In the Activity pages of this manual instructions are provided which can be duplicated for students.

Yes/No

The game entitled Yes/No is an excellent teaching tool for training students in determining the critical difference for items in a group. Two sample games, one for studying animals and another for studying rocks, are provided. Other games can be set up by the user (see Activities). The Yes/No program builds a knowledge base from the answers to a series of questions that can be answered with "yes" or "no". As the program is used, the knowledge base increases and should be saved when new items have been added.

Briefly, to use the sample program, think of an animal. The Yes/No program will ask a series of questions about the animal that can be answered with either "yes" or "no". Once the program has exhausted the questions it has stored along a logical path, it will attempt to guess the identity of the animal. If the guess is incorrect, the user is asked to enter a question that can be used to distinguish the animal that was guessed from the animal about which the user was thinking. The question that is entered for the new animal should be one that can be answered with either "yes" or "no". This new question and the animal will then be added to the knowledge base and asked in subsequent games.

Bagels

The game entitled Bagels is a challenging exercise in deductive reasoning. Reportedly, the concept of the game originated at the University of California at Berkeley. The object of the game is to use the clues that the computer provides to determine which of ten objects have been randomly selected. There are a variety of strategies that can be used in playing the game. Teachers may find it beneficial to give students some exposure to the game, and then have them verbalize the strategies that they use in playing the game.

The Bagels game can be played on three different levels of difficulty. The "Brain" level uses three pieces. The "Genius" level uses four pieces, and the "Wizard" level uses five. After the level is selected, the program displays the menu shown below, from which the user can select the appropriate number of pieces.

1 2 3 4 5 6 7 8 9 0

After the appropriate number of pieces have been selected the program asks the user to select either "Test" or "Revise". If "Test" is selected, the program will analyze the pieces selected by the player and compare the player's pieces to the pieces it has selected, and will then report "Pico" for each piece that is correct but in the wrong position, "Fermi" for each piece that is correct and in the right position, or "Bagels" if no pieces are correct. After running the test, the player can revise the selection based on the new information. The game continues until the player determines all the correct pieces or presses ESC (the escape key) to quit. In the activity pages, a record keeping form is provided which will help students in playing this game.

Hi-Lo

The third game, Hi-Lo, is the familiar "Guess the Number" game with a different twist. Instead of the user guessing the computer's number, the computer guesses the user's number. The user may select to play the game with four different ranges of numbers: 1 - 10, 1 - 100, 1 - 1000, or 1 - 10000. The larger the range, the more difficult the game.

Select Begin to start the game and the computer will guess its first number. After each guess the user responds either "Higher", "Lower", or "Correct". After the user responds with either "Higher" or "Lower" the computer will make another guess. When the computer guesses the correct number, the user selects "Correct".

The program illustrates a searching technique called a binary search, which is commonly used in computer programming. In the activity pages section a worksheet is included that suggests a project to use with the Hi-Lo game.

Grids

The Grids option from the games menu leads to two more choices:

Gridlogic Number_Magic

Gridlogic -The Gridlogic program plays logic games using the attributes of the various shapes. The object of the game is to play pieces by typing sentences such as "Put a blue square in (3,2)" to determine the rules that have been assigned to each column and row in the grid. If the command "Put a blue square in (3,2)" is given, the computer will check the piece against the rules for the column and row and either accept the piece or give a message back about the rules. The user carefully studies the pieces that are accepted and the messages, and uses logic to determine the rules that have been assigned to each row and column based on the responses of the computer. The object is to solve the puzzle in the fewest number of moves.

Number Magic - The Number Magic program begins by setting up a matrix of numbers. The object of the game is to try to select four numbers which, when added, do not equal Dr. Know's magic number. The arrow keys move the flashing indicator and the return key selects a number. When a number is selected, the other numbers in the same row and column are crossed out.

Name: ________________________________ Date: ________________

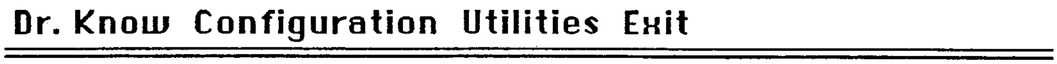
Activity #1 — Introduction to Expert Systems

There are many ways to define the term "expert system". Here is one definition:

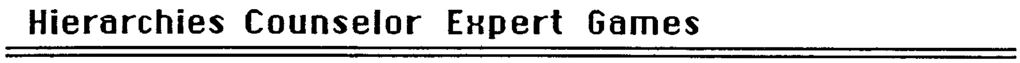
> An expert system is a computer simulation of the intelligence and reasoning process that a person who is an expert in a certain domain would use to solve a problem. An expert system uses a knowledge base that contains facts and rules along with a computer program which contains the procedures that are necessary to use this knowledge.

In this activity you will use the Hierarchies program, one of Dr. Know's expert systems. Later you will create your own expert system.

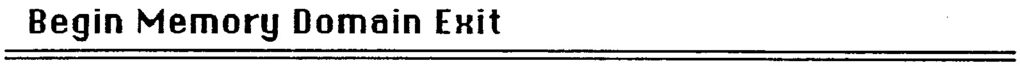
To get started put the Dr. Know program disk in the disk drive and turn on your system. The Main Menu shows these options:



From the Main Menu choose 'D' for Dr. Know and this menu will be shown:



Choose Hierarchies by pressing 'H' and the program is loaded. Once the program has been loaded the Hierarchies Menu is shown giving you these options:



When the Hierarchies program is first started its knowledge base is empty. A knowledge base is a set of facts about a particular subject that is structured in such a way that the computer can use the facts. Later you will use the Hierarchies program to create a knowledge base, add to a knowledge base, or use a knowledge base.

In this activity we will use an existing knowledge base. There is one on the Dr. Know program disk which is called Animals. It contains a set of facts about how animals are classified. To load the knowledge base into the computer's memory follow these steps:

1. Select Domain from the menu.

Name: ______________________________ Date: ________________

2. Select Catalog to view the available files. Then select 1 for drive #1. You should see two files:

    ANIMALS
    ANIMALS.UPPERCASE

3. Select Learn, then select 1 for drive #1 to load the knowledge base. Use the name ANIMALS if you are working on an Apple //e or Apple // c. (Be sure to type the file name in all capital letters.) Use the name ANIMALS.UPPERCASE if you are working on an Apple // plus. (The program is sensitive to upper and lower case. If you are using an Apple //e or Apple //c be sure the CAPS LOCK key is not depressed.)

4. Select Quit to leave the Domain Menu, then select begin.

Once you select begin, Dr. Know says "OK" and a question mark is shown with the cursor to the right.

Let's start exploring this knowledge base by asking Dr. Know these questions:

Is a monkey a bird?
Is a monkey a vertebrate?
Is a robin a vertebrate?

Whenever Dr. Know answers a question you can ask for an explanation. Type "Why" or "Explain" and Dr. Know will attempt to show the logic used in arriving at the answer that was given.

Let's add some information about robins to the ANIMALS knowledge base. Type "A robin is a bird." Now ask, "Is a robin a vertebrate?", and then ask Dr. Know to explain.

You will notice that Dr. Know has a good understanding of the way animals are classified. You may have also noticed that Dr. Know can learn about new animals and fit them into the hierarchy.

Lets add some more information to the ANIMALS knowledge base. Type these statements:

a whale is a cetacean
a cetacean is a mammal
a giraffe is an ungulate
an ungulate is a mammal
a fly is a dipteran
a dipteran is an insect

Name: ______________________________ Date: ______________

Ask Dr. Know if a fly is an animal by typing "Is a fly an animal?". Dr. Know responds, "I cannot draw that conclusion from my current knowledge." Of course we know a fly is an animal so let's tell Dr. Know.

This is the reasoning that could be used to arrive at the conclusion that a fly is an animal:

a fly is a dipteran
a dipteran is an insect
an insect is an arthropod
an arthropod is an animal

We need to check how much of this Dr. Know currently understands. Type "Is an insect an arthropod?" Dr. Know says "Yes". Ask, "Is an arthropod an animal?" and Dr. Know states that the conclusion cannot be drawn from the current knowledge base. So what is missing is the link between arthropods and animals. Tell Dr. Know that an arthropod is an animal. Type "An arthropod is an animal." Then ask the question about flies again. Type "Is a fly an animal?". This time Dr. Know says "Yes.". Ask for an explanation by typing, "Why?".

Use the program to teach Dr. Know about other animals. Try asking some questions. After you have added at least five animals to the knowledge base write three questions that Dr. Know will answer with 'yes' in the boxes given below.

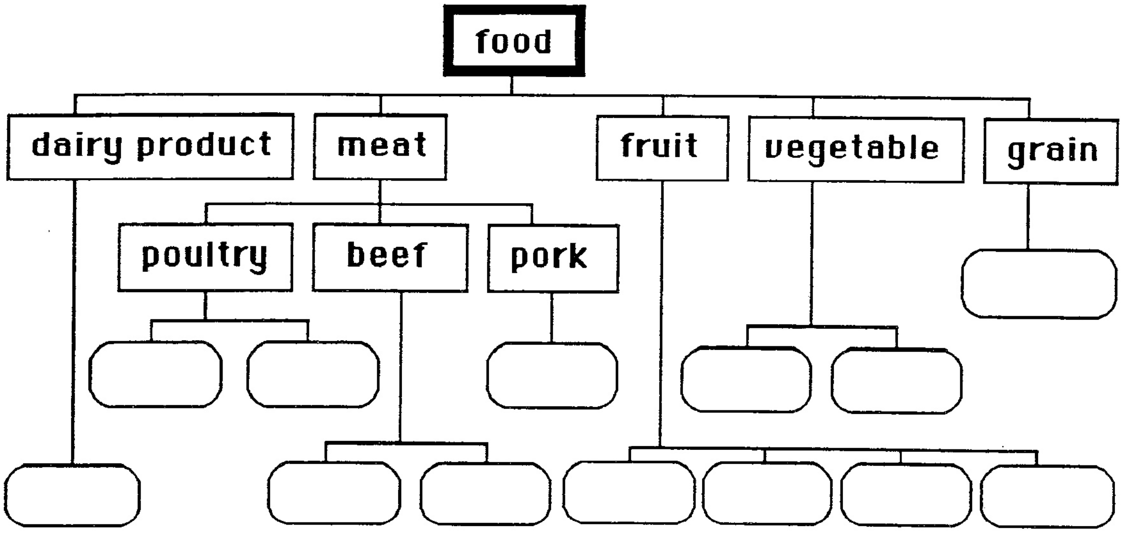
When you are finished, press RETURN next to the "?" prompt without making any entry. The program returns to the menu. When the menu is restored, choose Exit to return to the Main Menu. So that other people can use this activity with the animals knowledge base, do not save these additions to the knowledge base.

Name: ______________________________ Date: ______________

Activity #2 Creating a New Hierarchical Expert System

In this activity you will set up a new expert system using the Hierarchies section of Dr. Know. Before you begin, prepare a data disk using the Utilities option from the Main Menu if you plan to save the Knowledge Base created in this exercise. To begin, choose Dr. Know from the Main Menu and then select Hierarchies.

To start a new hierarchical type of expert system for Dr. Know, simply select Begin. In this activity you will create an expert system where the domain is food. Below is a diagram showing how this expert system will be structured.



Dr. Know will understand most of your sentences as long as they are in this form:

is a

Enter each statement about food by typing:

a dairy product is a food
a meat is a food
a fruit is a food
a vegetable is a food
a grain is a food

Name: ______________________________ Date: ________________

For meat we have three subgroups. Tell Dr. Know about each type of meat by typing these phrases:

poultry is meat
beef is meat
pork is meat

Now think of some types of food. Tell Dr. Know about the food by typing statements like the following:

cheese is a dairy product
lettuce is a vegetable
a cherry is a fruit
steak is beef

Complete the knowledge base by typing sentences that add a type of food for each blank in the diagram.

For this knowledge base, write three questions in the spaces below that Dr. Know will answer with "Yes". Then try them at the computer.

Name:______________________________ Date:_______________

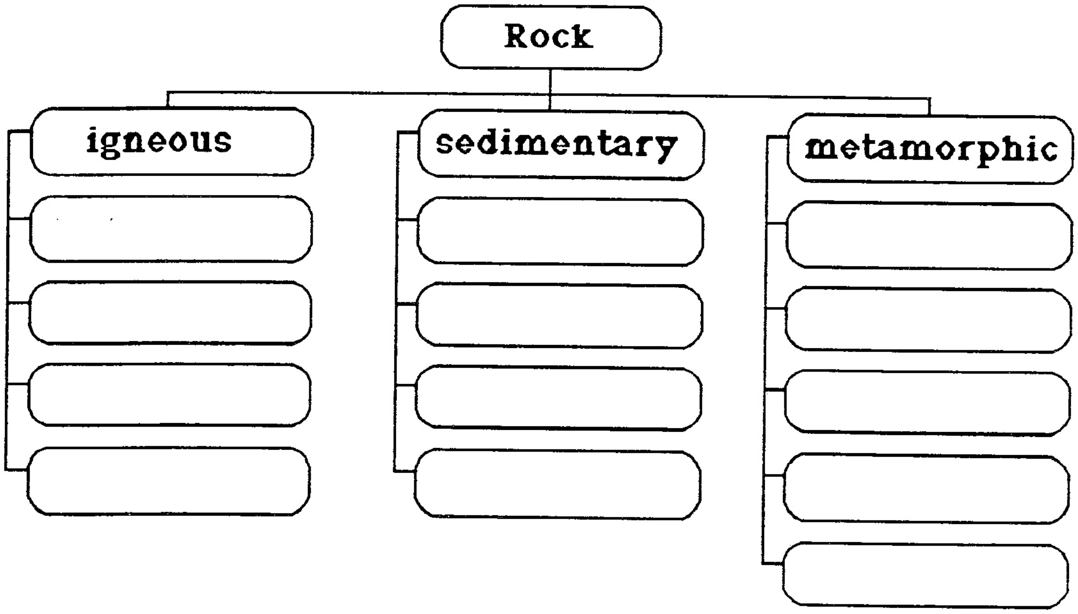
Activity #3

Classifying Rocks

The Hierarchies program on Dr. Know is an artificially intelligent data base that can be used to develop a rock classification scheme. All rocks have identifiable characteristics. Igneous rocks, for example, are formed when super heated magma from the earth's core cools. Igneous rocks usually have a coarse surface. Granite, basalt, obsidian, and pumice are examples of igneous rocks.

Some rocks are formed in layers as sediment and are called sedimentary rocks. Conglomerates, sandstone, shale and limestone are some examples of sedimentary rocks. Rocks which are formed when the forces of pressure and heat change igneous and sedimentary rocks are called metamorphic rocks. Gneiss, schist, quartzite, slate, and marble are examples of metamorphic rocks.

Complete the chart below to show the different families of rocks. Set up a knowledge base on rocks using the Hierarchies program.



As a research project find out more about the specific varieties of rock. For example, add to the knowledge base information about the names of different types of granite.

Name: ______________________________ Date: ________________

Activity #4 Conversations with the Counselor

The counselor program is a part of Dr. Know that provides an example of what is called natural language processing. From 1964-1966, Joseph Weizenbaum, a professor of computer science at the Massachusetts Institute of Technology, worked to create a program called ELIZA. The program was designed to use natural language in simulating the role of a Rogerian psychotherapist. Weizenbaum's intention was to parody this type of psychotherapy, which was based on the work of Carl Rogers. In Rogerian therapy the counselor does not try to direct the conversation. The psychotherapist reflects the patient's remarks back to the patient by restating the patient's comments. The direction of the conversation is entirely dependent on the patient. The Dr. Know Counselor program allows the user to experiment with a simulated conversation of this type using a natural language processing system.

Dr. Know's Counselor program has two parts. One part, the Editor, allows the user to create a "script" for the conversation. A script is a domain of responses which create a certain feeling in the conversation. The other part, the Conversation, allows the user to carry on a simulated conversation with the computer. In the conversation mode Dr. Know is constantly looking for "triggers". Triggers are key words or phrases that cause the program to select one of three phrases to give in response to the trigger. If the user makes a statement that does not contain a trigger, the program will randomly use one of its general responses.

Let's try some experiments! To begin, select Dr. Know from the main menu and then choose Counselor, and then Conversation_Mode. (Later you will try the editor.) The menu is shown below:

The original program disk contains two scripts for the Conversation Mode of the Counselor. Each of the scripts contains a different set of triggers and corresponding responses. To select a script, first select Domain from the Conversation_Mode menu, then choose the drive location of the disk which contains the conversation file (In this case select "1"). A list of the available scripts is shown. Select the General script by pressing the number 0. Then select Begin. Dr. Know will tell you to wait for a moment. Then the question "How are you today?" will be displayed. To use the program, type a response and press enter. As the conversation proceeds, you will notice that Dr. Know seems to be interested in you. Try the program for a while to get a feel for how it works. If you would like to exit the Conversation Mode and restore the main menu press Return next to the question mark without making any response.

Name: ______________________ Date: ____________

Many of the responses that Dr. Know will make will seem to be intelligent. In the spaces below record two of Dr. Know's responses that you find particularly intelligent.

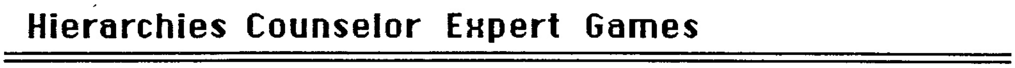
Occassionally, Dr. Know will make a comment that does not make much sense. Record two nonsensical comments below.

Based on what you know about computers, why do you think Dr. Know made some comments that were nonsensical?

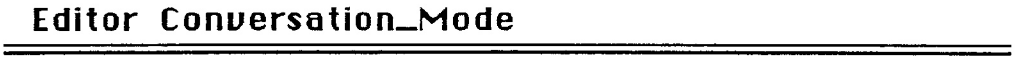
Name: ______________________________ Date: ______________

Activity #5 Creating a Script File

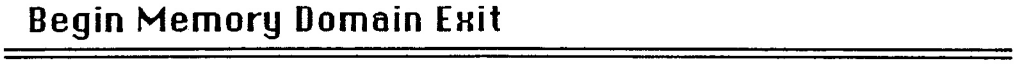
Dr. Know gives you the facility to create new script files to be used with the counselor. A script file is a set of triggers and responses. Triggers prompt Dr. Know to give one of three possible responses. In this activity you will create a script that could be used to help a person explore feelings about his or her family. To access the script file editor select Dr.Know from the main menu, then choose Counselor from the second menu.



Once Counselor has been selected, choose Editor from the next menu.

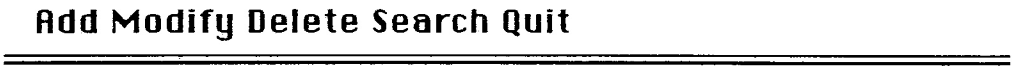


The system will load the Editor program and then display this menu:



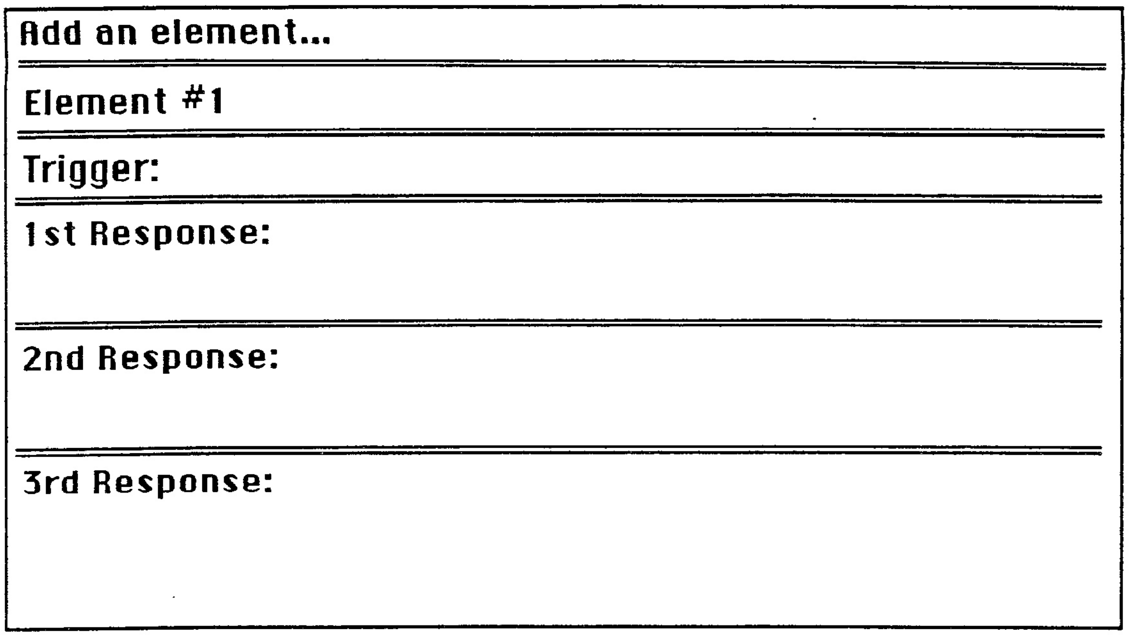
To start a new script file select Domain, then New, then drive 1. The program will display a list of files. If no other scripts have been previously added file #2 will say "Empty". Select #2 or any file that is empty. The system will request a file name. At this point enter a descriptive name for the file. In this example we will make a script file to help a person explore feelings about his or her family. Use the name FAMILY for the file name. Type FAMILY and press return. The Editor menu will be restored.

Select Begin. The Operation menu shown below will be given.



Select Add and the form for adding script elements will be shown.

Name: ______________________________ Date: ______________



Add an element...

Element #1

Trigger:

1st Response:

2nd Response:

3rd Response:

Triggers

Triggers are special words or phrases which the Dr. Know Counselor program uses to keep the conversation moving. Sentences which contain triggers will contain two parts, the word or phrase which is the trigger itself and the remaining part of the sentence which is called the "trailer". The trailer can be used to reflect back to the user part of what is said. This gives the impression of being understood.

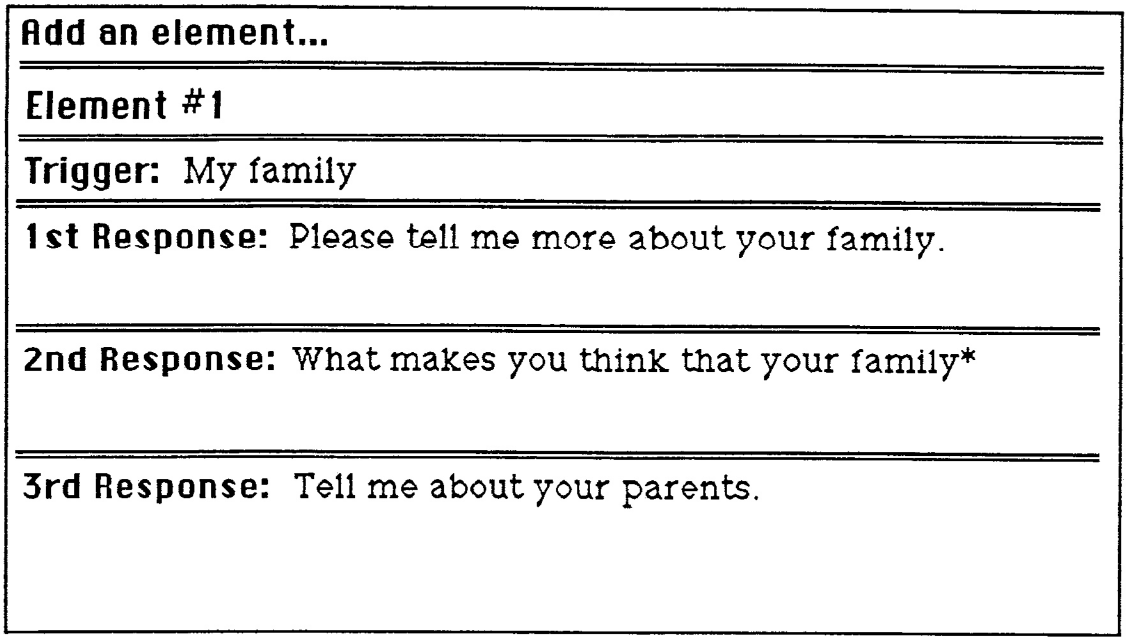
Responses

When the conversation program is used, each sentence entered by the user is analyzed. If a trigger is found in the sentence the program randomly selects one of the three responses. Responses can be set up to use or not use the trailer.

Entering the First Script Element

When you select to add a script element the cursor automatically moves to the trigger field where you can enter a short trigger. For the first element in this script type "My family".

Name: ______________________ Date: ____________



Add an element...

Element #1

Trigger: My family

1st Response: Please tell me more about your family.

2nd Response: What makes you think that your family*

3rd Response: Tell me about your parents.

Using Trailers: Notice that the second response is not a complete sentence and ends with a "*". This is how Dr. Know can be told to use a trailer. For example, if the person using the program wrote the sentence "My family is bothering me." the phrase "is bothering me" is a trailer. If Dr. Know randomly selects to give response #2, the trailer will be used within the response. In this case if response #2 is selected, Dr. Know will respond "What makes you think that your family is bothering you?" Notice that Dr. Know automatically replaces the pronoun "me" with the pronoun "you" so that the sentence makes sense.

All that is needed for the response to contain a trailer is to use an asterisk (*) at the end of the sentence. It is not necessary to put a space before the asterisk.

Imagine that you are a counselor sincerely trying to help somebody explore their feelings about their family. Play the role of a counselor as you complete this exercise. Use copies of the Script Planning Sheet to plan your triggers and responses.

In creating the script remember that you want to create a dialogue that will help a person understand his or her feelings about his or her family. As a counselor you do not want to be judgemental nor do you want to dominate the conversation. If you need to change one of your script elements you can do this by selecting Modify from the Operation menu. The program will request the number of the element to be editted. When the element is found the Modify menu shown below will appear:

Name: ______________________________ Date: ________________

Select Trigger to change the trigger or 1, 2, or 3 to change one of the responses. When the element has been modified satisfactorily select Ok. To cancel the changes made from the modify menu and leave the element as it was before the modifications were made select Cancel. After Ok or Cancel are selected the program returns to the Operation menu.

To delete an element from the script file select Delete from the Operation menu. The program will ask for the number of the element to be deleted. After the number is entered the program will show the element on the screen. Select either "Delete_This_Element" to remove the element or "Cancel" to leave the file unchanged.

To find an element use the Search option from the Operation menu. When search is selected the program automatically displays the first element. To move through the elements sequentially select Next. To back up select Previous. To jump to a specific element select Jump. To exit the Search mode select Quit.

Once the file has been editted satisfactorily select Quit from the Operation menu. To save the file select Domain and then Store. The file is automatically written to the disk. Select quit for the Editor menu

After you have created a script you can try it out by selecting Exit from the Operation menu and return to Dr. Know's main menu. From there select Dr. Know, Counselor, Conversation_Mode. When the menu shows the choices Begin, Domain, Quit select Domain and then the drive number, and then select your script. Dr. Know will now use your set of triggers and responses in the conversation.

Name: ______________________________ Date: ________________

Script Planning Sheet

Element #	1st Response
Trigger	2nd Response
	3rd Response

Element #	1st Response
Trigger	2nd Response
	3rd Response

Element #	1st Response
Trigger	2nd Response
	3rd Response

Name:________________________________Date:________________

Activity #6

A Program That Learns

In this activity we will examine a program that learns. Select Dr. Know from the main menu, then select Expert. Once the Expert system program has been loaded the menu choices Begin, Domain, Quit are presented.

What Is An Expert System?

You may recall the definition of an expert system from Activity #1.

> An expert system is a computer simulation of the intelligence and reasoning process that a person who is an expert in a certain domain would use to solve a problem. An expert system uses a knowledge base that contains facts and rules along with a computer program which contains the procedures that are necessary to use this knowledge.

In the first activity we learned to use a program that was able to simulate human reasoning. Based on the body of facts given, the program was able to draw a conclusion. The program was particularly well suited for performing logical operations which involved hierarchies.

In this activity you will explore a program that learns from its mistakes. The initial program is set up to demonstrate how the program gains knowledge about a subject. To begin select Domain from the menu. The options shown below will be presented.

```
New Learn Store Knowledge Reset Quit
```

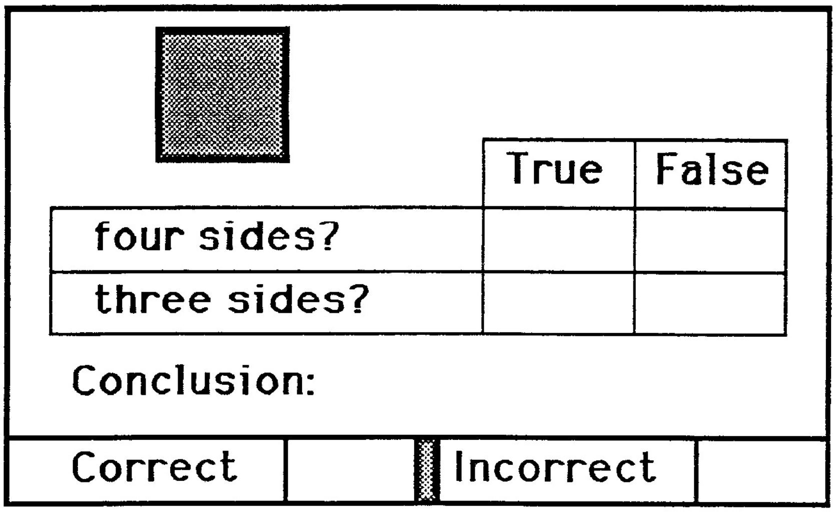
Select Knowledge to view the current state of the computer's memory with regard to the knowledge base. The program responds that the knowledge base includes the items quadrilateral and triangle.

Select Quit to exit the Domain menu.

In this activity we will help the computer learn to identify quadrilaterals and triangles. Select Begin to start using the Expert system. The program will ask you to respond to a series of questions and then it will attempt to draw a conclusion. The conclusion may not be correct. It is up to you to set up the expert system by helping it to learn the difference between quadrilaterals and triangles. As you do this the program will become smarter. Eventually the program will always identify quadrilaterals and triangles correctly.

Think about the shape shown below as you answer the True/False questions presented by Dr. Know.

Name: ______________________________ Date: ________________

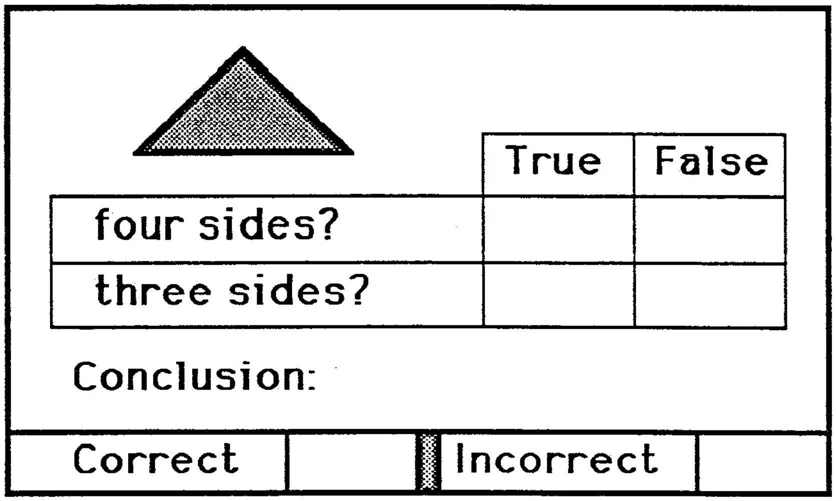


	True	False
four sides?		
three sides?		

Conclusion:

Correct		Incorrect	

After you have answered the two questions Dr. Know will make a guess about what the object is that you are trying to identify. The guess may be correct the first time but usually will be incorrect. Since you are the "expert" it is your job to teach the computer. Respond either "Correct" or "Incorrect", then do the activity again by selecting continue. This time answer the questions for the shape shown below.



	True	False
four sides?		
three sides?		

Conclusion:

Correct		Incorrect	

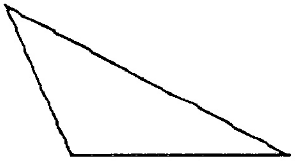
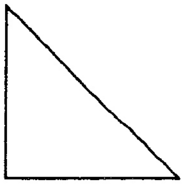
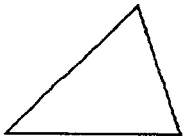
Repeat the process of giving answers to the series of questions as many times as necessary until the system no longer incorrectly identifies any triangle or quadrilateral. If you confuse the system by telling Dr. Know that the object that you are trying to identify has both three sides and four sides this response is given:

> *None of the outcomes can be identified using the factors and conditions specified.*

Name: ______________________________ Date: ______________

Activity #7 Setting Up an Expert System

In this activity you will set up an expert system from scratch. To begin from the main menu select Dr. Know, then Expert. The first step in setting up a new system is to do some planning. In this activity we will set up an expert system to identify triangles. Triangles can be classified on the basis of their angles. The chart below shows what is true about obtuse, right and acute triangles.

		
OBTUSE One angle greater than 90° and two angles less than 90°.	**RIGHT** One angle equal to 90° and two angles less than 90°.	**ACUTE** All three angles less than 90°

Three statements which can be evaluated true or false are needed in order to set up the expert system so that it can classify triangles on the basis of their angles. The three true/false statements are:

1. The triangle has an angle greater than 90°.
2. The triangle has an angle equal to 90°.
3. The triangle has an angle less than 90°.

To set up an expert system that will learn how to classify triangles select Dr. Know from the main menu and then select Expert.

The first menu that appears after selecting Expert gives these choices:

Begin Domain Exit

Select Domain to obtain these choices:

New Learn Store Knowledge Reset Quit

Name: ______________________ Date: ______________

Select New to initiate a new knowledge base. The computer will request a title for the knowledge base. For this exercise use the word TRIANGLES as a title.

Next a screen will show that the number of outcomes is set for 2. In this example we have three possible outcomes: obtuse triangle, right triangle or acute triangle. Select Increase to change the number of possible outcomes to 3. Choose Accept. Next the system asks for the number of factors needed to choose between the three possible outcomes. Here again we need three factors. The factors are the true/false statements. Select Increase and then Accept. After the number of possible outcomes and the factors used to determine the possible outcomes have been entered the system requests the first outcome. Enter these possible outcomes:

Outcome	Word or Phrase
1	obtuse triangle
2	right triangle
3	acute triangle

After the possible outcomes have been entered the system will request the factors used to determine the possible outcomes. Enter the three statements used to determine the type of triangle when prompted.

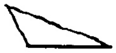
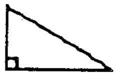
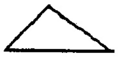
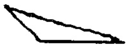
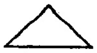
Factor	Statement
1	The triangle has an angle greater than 90°
2	The triangle has an angle equal to 90°
3	The triangle has an angle less than 90°

Once the factors have been entered the system will inform you that the knowledge base is complete and a menu giving the options Begin, Domain, Exit will be shown. The "truth table" shown on the next page shows how each factor is applied to each of the three possible outcomes.

Name: ______________________________ Date: _______________

	Factor		
Outcome	1	2	3
1 obtuse	T	F	T
2 right	F	T	T
3 acute	F	F	T

Select Begin and then Continue to start using the expert system. First the system will tell you the three possible outcomes. Select continue and then answer "True" or "False" for each statement that is presented. Use the figures given below and respond with True or False as appropriate for each triangle. Repeat the procedure of responding true or false to the series of statements until the triangle is correctly identified. Use the chart to show how the expert system learns by keeping a record of how many trials are needed for the system to correctly identify the triangle.

	Figure	Type of Triangle	Trials
1			
2			
3			
4			
5			

Name: ______________________________ Date: ________________

Expert System Planning Sheet

A. Select a title: ________________________

B. Outcomes: In the spaces below write a word or phrase to describe each of the possibles outcomes for your expert system. It is not necessary to use all of the spaces.

	Word or phrase describing possible outcome.
1	
2	
3	
4	
5	
6	
7	

C. Factors: In the spaces below write statements that can be tested as true or false to determine one of the possible outcomes.

	A true or false statement for determining an outcome.
1	
2	
3	
4	
5	
6	
7	

Name: ______________________________ Date: ______________

Expert System Planning Sheet (part 2)

D. Truth Table: On this page think about each of the possible outcomes. For each of the outcomes determine if each factor is true or false.

Truth Table		Factors						
		1	2	3	4	5	6	7
Outcomes	1							
	2							
	3							
	4							
	5							
	6							
	7							

E. Setting Up the System: Choose Dr. Know, then Expert from the menu to enter the Expert Program. Since you are creating a new area of expertise for Dr. Know choose Domain from the menu. Follow these steps:

1. Select New and enter your title for this knowledge base.
2. Choose Increase or Decrease to set the number of possible outcomes.
3. Enter the number of factors.
4. Enter each of the possible outcomes.
5. Enter each factor.
6. Think about one of the possible outcomes. Keep it in mind as you do the next steps.
7. Select Begin and answer True or False to each statement as it pertains to the outcome.
8. When the computer selects an outcome, tell it correct or incorrect.
9. Repeat steps 6, 7 and 8, until the computer is usually right.

F. Storing Your Knowledge Base: After you are done with the training phase, select Stop from the menu and then choose Domain. Select store and choose one of the available storage files for your knowledge base. When you retrieve your knowledge base the knowledge that you gave it in the training phase will be remembered.

Name: ______________________________ Date: ________________

Activity #8 A Program that Learns Using Just Yes/No

In this activity you will use a program that learns. From the main menu select Dr. Know and then choose Games. Select the first choice in the game menu which is Yes/No. To get familiar with the program we will use a knowledge base about animals.

Think about a dog and then select Begin from the menu. The program will respond:

> Are you thinking of an animal?

Since you are thinking about a dog respond "yes". The next question appears:

> Does it have fur?

Again the answer is yes so select "yes". Now the computer guesses:

> Is it a mouse?

Since you were thinking about a dog respond "no" to this question. The computer will ask for the name of the animal that you were thinking about. Type "dog" and press return. Now the computer asks you to think of a question that will distinquish a dog from a mouse.

Type:

> Is the animal a rodent?

Next the computer will respond:

> Would the answer be yes or no for a dog?

Since a dog is not a rodent select "no". The program returns to the menu and has learned a question that can distinquish a dog from a mouse. Continue thinking of animals and using the program. After you have set up a number of animals try the program with a friend who does not know which animals you have entered. As you add more and more animals the program gets better at identifying the animal that a person picks.

To store the knowledge base select Domain, then Store. The computer will request a number for the drive. Select a drive. The computer will list the Yes/No files on that disk. Select a number from 1-9 to store the file. If the file selected is not EMPTY the new data will overwrite the existing data.

Use Yes/No to set up a knowledge base on any subject. Some ideas are: types of trees, countries, movie stars, baseball players, anatomical parts of a type of animal, kinds of fish, or rocks and minerals.

Name: ______________________________ Date: ________________

Activity #9 Bagels • Practicing Deductive Reasoning

Deductive reasoning is the process of drawing a conclusion from a set of premises. In the game Bagels, you are challenged to determine the correct pieces and positions. The game can be set for either three, four or five pieces. Select Dr. Know, Games, and then Bagels to start the game.

Once the game has been loaded a Menu shows these choices: Begin, Instructions, Quit. Select Instructions to read the instructions for the game. Then select Begin.

For this activity we will set the game for three pieces. After selecting Begin choose the Brain level. The computer instantly creates your puzzle and the menu bar shows the line below:

```
1 2 3 4 5 6 7 8 9 0
```

Select any three numbers. You may select the same number more than once. On the reverse side of this page are a series of boxes like the boxes shown below. Use the boxes on the Bagels Record Sheet to record your choices. After three choices have been entered the computer will present the menu options Test or Revise.

Guess			Feedback

Choose Test and the computer will give you feedback about your choices. Record the feedback in the box to the right of your choices. Use P for Pico, F for Fermi and B for Bagels. The feedback will help you to deduce the three pieces selected by the computer and to determine their correct positions. Try to get Fermi, Fermi, Fermi in the fewest number of tries.

Name: ______________________________ Date: ________________

Bagels Record Sheet

Brain Level

Guesses			Feedback	Guesses			Feedback

Genius Level

Guesses				Feedback	Guesses				Feedback

Wizard Level

Guesses					Feedback	Guesses					Feedback

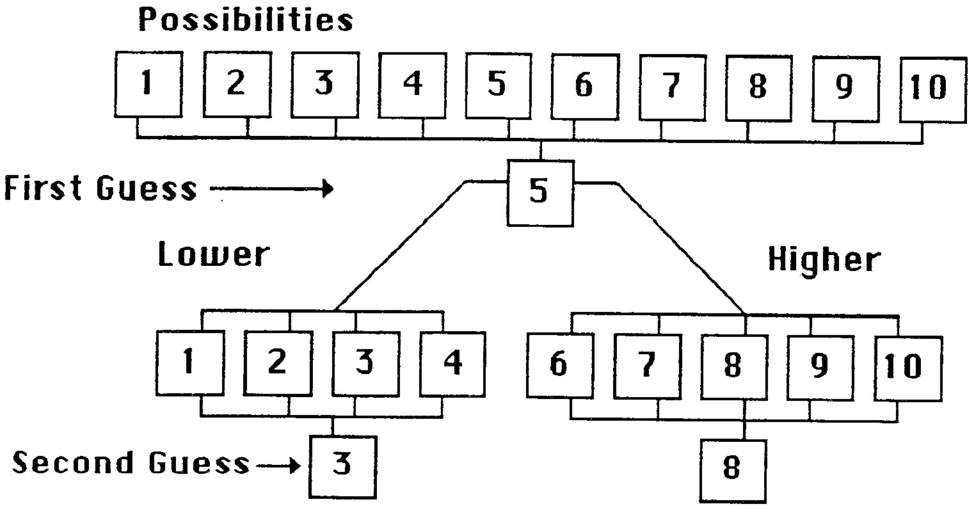
Name: ______________________________ Date: ______________

Activity #10

Hi-Lo

The game called Hi-Lo is a computerized version of the Guess the Number game. The program demonstrates a binary search technique for selecting a specific item from a list of items that have a specific order. After reading the instructions choose a number from 1-10, then select Begin. Give feedback to Dr. Know by choosing Higher, Lower or Correct after each guess.

Here is how a binary search works.



The process of choosing the number in the middle of the range is repeated over and over until the correct number is picked.

Try the Hi-Lo game for different ranges of numbers to see how it works.

Use the number seven (7) and play the game once in each of the ranges. How many guesses were needed for Dr. Know to guess the number in each range?

1 to 10 ? ____________ 1 to 100 ? ____________

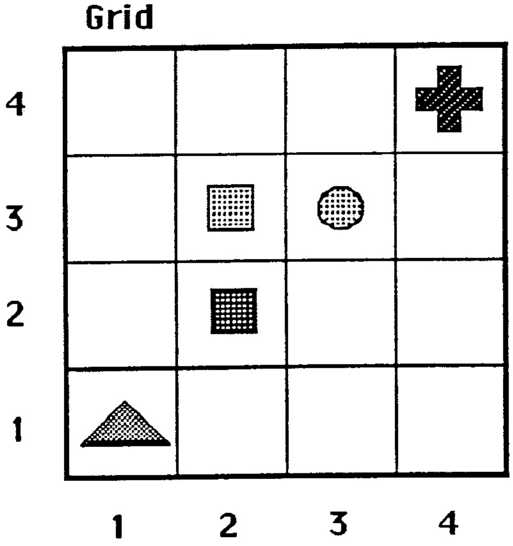
1 to 1,000? ____________ 1 to 10,000 ____________

Name: ______________________________ Date: ________________

Activity #11

Gridlogic

Under the Grids choice of the Activity Menu two options are given: Gridlogic and Number_Magic. For this activity choose Gridlogic. The Gridlogic game uses a simple natural language processing system to interpret your moves in solving the puzzle. The program uses sixteen playing pieces. Each piece has two attributes: color and shape. One attribute will be assigned to each row and column of the grid. Below is an example of how a puzzle could be solved without playing every piece.



Pieces

✚	violet cross
■ ●	orange square and circle
■	blue square
▲	green triangle

Rules:

	Column	Row
1	Triangle	Green
2	Square	Blue
3	Circle	Orange
4	Cross	Violet

Reasoning: Since an orange square and an orange circle were accepted in row 3, you can deduce that the color attributes have been assigned to the rows and that the shape attributes have been assigned to the columns.

Read the instructions provided in the program and then select Begin. Since the object of the game is to determine the rules that have been assigned to the rows and columns of the grid, it would be helpful to develop a strategy for solving the puzzle. Answer these questions on separate paper after you have solved the puzzle.

1. What strategy did you use to solve the puzzle?
2. How well did your stategy work?
3. Revise your strategy and try it again. How well did your new strategy work?

Name: ______________________________ Date: ________________

Activity #12

Number Magic

The object of Number Magic is to try to select 4 numbers which do not add up to Dr. Know's Magic Number. To use the game select Grids from the Activity Menu and then select Number Magic. Read the instructions and then press Begin. Try the game five times using the Sequential format and then try the game five times using the Random format. Tally your score in the grid below.

Number Magic	Dr. Know	You
Sequential		
Random		

Did it seem to you that it was impossible to win most of the time? If so, you were right. Number Magic is a mathematical trick that you can play on your friends. Here is how it works:

	1	2	3	4
0	1	2	3	4
4	5	6	7	8
8	9	10	11	12
12	13	14	15	16

The numbers:
1, 2, 3, 4, 0, 4, 8, 12
are examples of base numbers that are used to generate this grid.

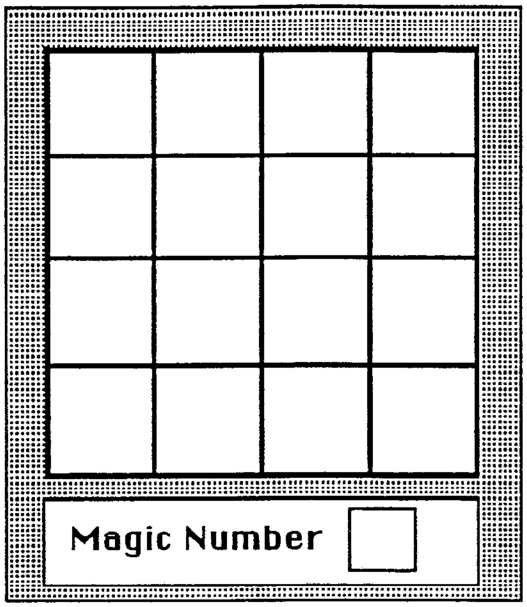
The sum of the base numbers is 34.

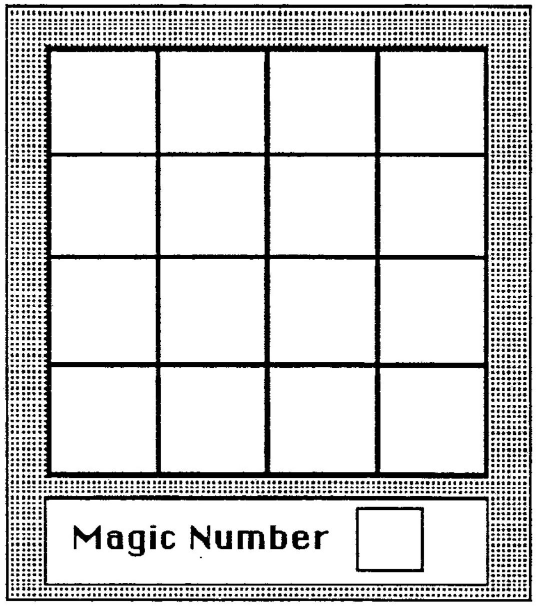
Every time a number is selected the remaining numbers in the same row and column are crossed out. This procedure insures that each of the four numbers that you select is the sum of two different base numbers. When you are finished selecting four numbers their sum will always be the sum of all eight base numbers. It does not matter which number you start with; the four numbers you choose will always equal the sum of the base numbers.

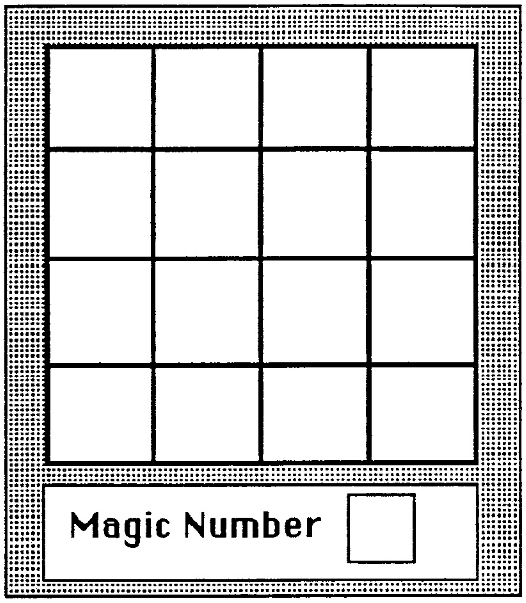
Name: ______________________________ Date: ________________

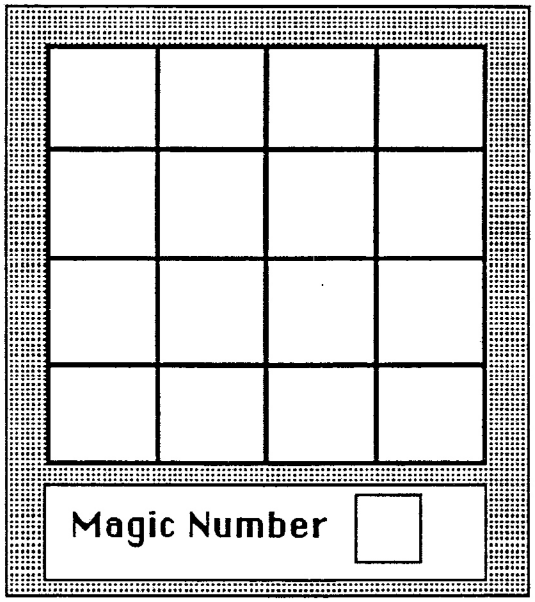
Dr. Know could win the game every time. Occasionally Dr. Know will let you win but this will not happen very often. Use the blank Number Magic grids to make your own puzzles. Try this trick on your friends.

Number Magic Grids









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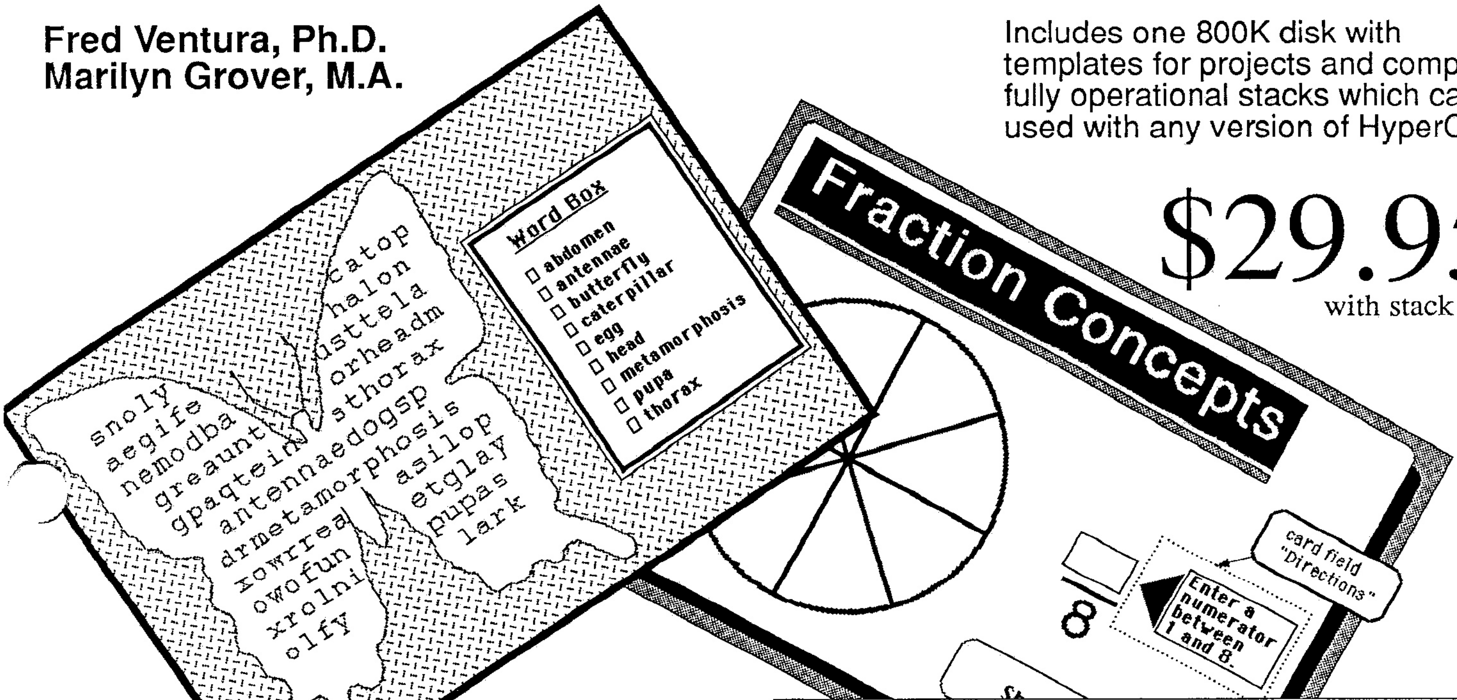

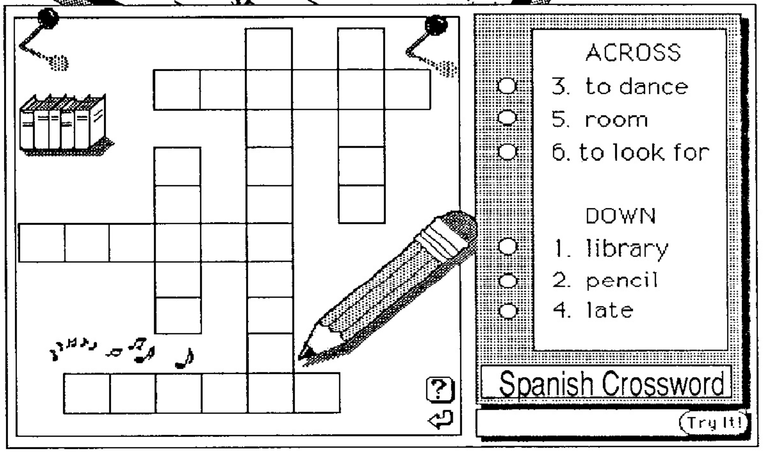

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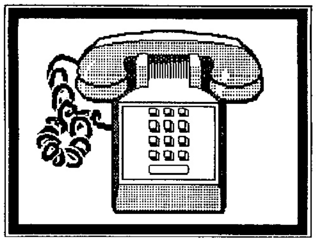

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